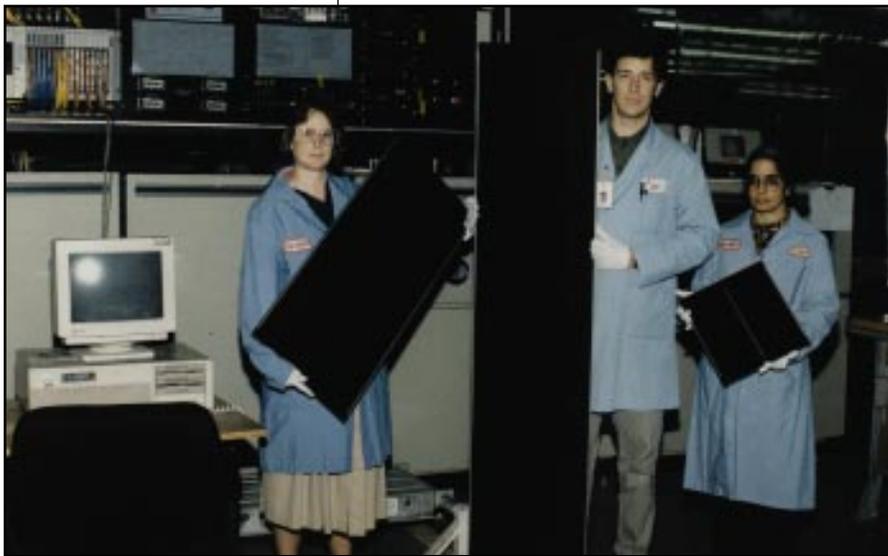


# Solarex Corporation

R&D Partner

## Background

Amoco Corporation acquired Solarex's polycrystalline photovoltaic (PV) business in 1983. At the same time, it also bought the amorphous silicon (a-Si) thin-film technology from Radio Corporation of America (RCA), where this technology was pioneered from the mid-1970s, and formed the Solarex Thin-Film Division. Dr. David Carlson and four scientists came to Amoco from RCA to start up the Thin-Film Division. The purpose of the division was to pursue research and development (R&D) and to commercialize a-Si technology.



Examples of prototype a-Si-based thin-film PV modules in sizes up to 8 ft<sup>2</sup> to be commercialized by the Amoco/Enron joint venture. At present, these modules are capable of producing more than 55 watts of electric power under stabilized conditions.

In FY 1983, the Solar Energy Research Institute (SERI)—later to become the National Renewable Energy Laboratory (NREL)—began a government/industry cost-shared, 3-year (FY 1984–FY 1986) integrated research program for accelerating the advancement of the a-Si module technology at U.S. companies. Solarex's Thin-Film Division was awarded a \$5 million contract (with a \$1.63 million cost share) for a 3-year period under this program.

A second government/industry cost-shared program subcontracted by SERI was started in FY 1987 and was to be conducted over the period FY 1987–FY 1989. The emphasis of this research program was on multijunction a-Si technology and improved performance. The Solarex Thin-Film Division was one of four organizations to be funded under the second cost-shared program in the amount of \$9.79 million (including Solarex cost-sharing \$5.02 million) over a 3-year period.

A third cost-shared program was started in 1990 and another 3-year award was made to Solarex in the amount of \$6 million (with Solarex cost sharing \$3.1 million) over a 3-year period.

Under the Thin-Film Partnership Program team arrangement, Solarex was awarded a 3-year contract for \$2.5 million in 1994 (including Solarex cost sharing \$1.26 million over a 3-year period). The purpose of the Partnership Program is to provide an opportunity to bring more cost-competitive solar panels to the marketplace and to provide a basis for improvements in PV device designs for future efficiency increases.

## Technical Highlights

The Solarex Thin-Film Division has been a leader in a-Si research, development, and manufacturing. It was the first U.S. company to introduce a-Si modules for calculators and other low-light applications in 1984. It was the first company to demonstrate 10% initial efficiency on a-Si single-junction modules (1 ft<sup>2</sup>) in 1987. Solarex started manufacturing a-Si single-junction products for outdoor applications in 1986 and was the first organization to build a 1-MW/yr-capacity pilot, computer-integrated manufacturing (CIM) line in 1990. Since 1990, Solarex has been a leading supplier of small (<10 watt) thin-film a-Si products. A portion of the computer-controlled production line and examples of three production modules ranging from 1 ft<sup>2</sup> to 8 ft<sup>2</sup> are shown in Figure 1.

In 1987, Solarex's Thin-Film Division extended its single-junction device research to include wide- and narrow-bandgap a-Si alloys and multijunction devices and modules. Solarex has demonstrated dual-bandgap, triple-junction modules (1 ft<sup>2</sup>) with initial efficiency of 11.35% and dual-bandgap, dual-junction modules (1 ft<sup>2</sup>) with initial efficiency of 10.5%. The stabilized efficiency demonstrated for both types of modules is about 9%. In 1994, Solarex decided to rapidly commercialize its multijunction technology. It scaled up its dual-bandgap, dual-junction modules to 4 ft<sup>2</sup> and demonstrated over 9.75% initial efficiency and about 7% stabilized efficiency in pilot production. The 4-ft<sup>2</sup> multijunction modules have also been subjected to standard accelerated tests and qualified for outdoor applications. Presently, Solarex is scaling up the multijunction technology to ~8 ft<sup>2</sup> in a new 10-MW plant in Virginia (see below).

Research and development work by Solarex under the Partnership Program addresses technical issues of solar cell and solar panel development to consistently reach a high

stabilized conversion efficiency. It covers material research of the various alloys used in the solar modules by different deposition technologies. It also incorporates these materials into multi-junction modules designed to capture different parts of the solar light spectrum to increase the sunlight-to-electricity conversion efficiency.

One goal is to obtain 10% stabilized efficiency solar panels of about 0.1 m<sup>2</sup> size that will pass the NREL Qualification Tests. The technology to be developed will also play a role in Solarex's near-term manufacturing plan for large-volume production of large-size (~0.7 m<sup>2</sup>), low-cost solar panels.

## Future Plans

On December 19, 1994, Amoco Corporation and Enron Corporation, two giants in the fossil fuel industry, announced a joint venture to develop solar-powered electric generating facilities around the world. The joint venture, Amoco/Enron Solar, will be headquartered in Frederick, Maryland. "This joint venture brings together the strengths of two excellent energy companies to deploy a technology that we believe will become a major source of energy for the world economy in the next century," said Amoco Corporation vice chairman Lawranson D. Thomas. Enron Corporation vice chairman John A. Urquhart said, "Our joint venture with Amoco builds on Enron's strategy of providing clean energy to the world economy. This is the technology that will allow us to provide solar electric power at competitive prices, both in the United States and in other areas around the world."

The joint venture will have two divisions: Solarex and Amoco/Enron Solar Power Development (AESPD). Solarex will be responsible for module production, sales, and research and development; and AESPD will be responsible for the development of worldwide power marketing and for projects that produce and sell solar energy. The board of the joint venture, co-chief executive officers Dr. Harvey Forest, who is responsible for Solarex, and Mr. Robert C. Kelly who is responsible for AESPD. The other board members include Robert C. Carr, president of Amoco Technology Company and John A. Urquhart, vice chairman of Enron Corporation.

Amoco/Enron Solar will continue to research and develop a-Si. Amoco/Enron Solar has built a new thin-film PV module manufacturing plant in Virginia with an annual capacity in excess of 10 MW of large area (~0.7 m<sup>2</sup>) multijunction a-Si modules. Development and advancement of this technology was achieved with substantial funding from the U.S. Department of Energy (DOE), as mentioned above. The plant, which is to start production by the end of 1996, will start up with dual-bandgap, dual-junction modules of ~0.7 m<sup>2</sup>-area having about 8% stabilized efficiency. To reach higher efficiencies and lower costs, Solarex and the DOE/NREL Thin-Film Partnership will continue research on a-Si-based thin-film materials, devices, and modules both for dual-junction and for triple-junction modules.

For additional information, contact:

At NREL:

Tom Surek (303) 384-6471

Ken Zweibel (303) 384-6441

Bolko von Roedern (303) 384-6480

